2.4 Data Gaps

It is the responsibility of the states of Oregon and Idaho to write TMDLs using available data. The SR-HC TMDL has a very robust data set available for the evaluation of water quality impairment, pollutant load analyses and source identification. It is the states' discretion to accept or reject data. TMDLs are to use best available data and to include margins of safety to account for unknown factors. Both IDEQ and ODEQ believe there is sufficient data to develop a scientifically accurate TMDL for the SR-HC TMDL reach of the Snake River. The current TMDL schedules for both the State of Oregon and the State of Idaho do not directly address the amount of available data. The States are charged to write TMDLs using the best available data. Reasonable existing data sets have been identified to meet the needs of the SR-HC TMDL. The fact that more data could be collected is not a viable basis for delaying a TMDL.

Available data has been used in making the initial assessment of the TMDL and implementation targets for the SR-HC system. The phased implementation process discussed previously is in part intended to allow data to be collected for those constituents for which additional data would be helpful. If these additional data show that initial water quality targets should be refined, the appropriate changes will be undertaken. This assessment has identified those areas in which additional data is required in order to finalize the TMDL process, and those areas in which additional data would be helpful to refine the current designated use support determination. These are identified by pollutant category below.

Bacteria:

- Available data is adequate.

Dissolved Oxygen:

- Intergravel dissolved oxygen data or sediment/water interface data are required to accurately assess the level of impairment of aquatic life designated uses within the Upstream Snake River segment (RM 409 to 335). While only the upper section (RM 409 to RM 396.4) of the Upstream Snake River segment is listed for dissolved oxygen, data collected throughout the segment would be helpful in assessing the support status of the mainstem river.
- Currently available qualitative information show anaerobic conditions are occurring in the Upstream Snake River segment (RM 409 to 335) but are not adequate to quantify the level of dissolved oxygen available at the sediment/water interface.

Mercury:

- Additional water column mercury data is necessary to determine the current system loading and assign wasteload allocations. Water column data is especially critical in the Upstream Snake River segment (RM 409 to 335). Very little water column mercury data is available within the SR-HC TMDL reach (RM 409 to 188). US EPA does not recommend using fish tissue data and bioconcentration factors to determine water column concentrations. This TMDL has been delayed until 2006 (US EPA approved action) to allow data collection and additional watershed assessment to occur.

Nutrients:

- Additional chlorophyll *a* data would be helpful to refine current estimates of biomass loading to the Upstream Snake River segment (RM 409 to 335) and Brownlee Reservoir segment (RM 335 to 285).
- Additional information on periphyton and other aquatic growth would be helpful to refine current estimates of biomass loading to the Upstream Snake River and Brownlee Reservoir segments.
- Irrigation drain and return flow and concentration information (total and ortho-phosphate, and chlorophyll *a*) would also be helpful in refining the current estimates of loading.
- Data supplying information on ground-water inputs (flow and total and ortho-phosphate concentration) to the SR-HC TMDL reach (RM 409 to 188) would be helpful in refining the current estimates of loading.

pH:

- Available data are adequate.

Pesticides:

- Fish tissue data and water column data for both DDT and dieldrin in Oxbow Reservoir are critical for the assessment of use impairment in the listed segment. Similar additional data in the Brownlee Reservoir (RM 335 to 285) and Upstream Snake River segment (RM 409 to 335) are critical to the refinement of designated use impairment assessments in these segments as the current data set is limited. Water column data is critical to the determination of compliance with the SR-HC TMDL targets, and the calculation of loads.

Sediment:

- Sediment data that identify both concentration and duration are critical to the accurate assessment of aquatic life designated use support in the Upstream Snake River (RM 409 to 335) and upper Brownlee Reservoir (RM 335 to RM 315) segments. The current database contains instantaneous measurements only.

Temperature:

- Available data are adequate for a rough assessment of relative temperature influences in the Upstream Snake River (RM 409 to 335) and upper Brownlee Reservoir (RM 335 to RM 285) segments. Additional data would be helpful to refine this initial assessment. Concurrent monitoring of all appropriate stations (Murphy, Nyssa and Weiser on the mainstem Snake River, and all appropriate gage sites on the inflowing tributaries is not currently available. These data would greatly improve the accuracy of the current assessment. They would make possible the application of site potential modeling (SSTEMP or similar).
- Temperature data for Oxbow (RM 285 to RM 272.5) and Hells Canyon Reservoirs (RM 272.5 to 247), and the Downstream Snake River segment (RM 247 to 188) are currently being collected and will be available as part of the re-licensing process for the Hells Canyon Complex. These data will be of value to the implementation planning process.

- Data from the tributaries identifying the relative influences of anthropogenic and natural sources will be available as part of the TMDL process for those tributaries listed for temperature. These data will help to refine the current estimates of loading.
- Irrigation drain and return flow temperature data would also be helpful in refining the current estimates of loading.
- Data supplying information on ground-water inputs (flow and temperature) to the SR-HC TMDL reach (RM 409 to 188) would be helpful in refining the current estimates of loading.

Total Dissolved Gas:

- Available data are adequate for an initial assessment of the total dissolved gas loading to the Oxbow (RM 285 to 272.5) and Hells Canyon Reservoirs (RM 272.5 to 247), and the Downstream Snake River segment (RM 247 to 188).
- Total dissolved gas data for Oxbow and Hells Canyon reservoirs, and the Downstream Snake River segments are currently being collected and will be available as part of the re-licensing process for the Hells Canyon Complex. These data will be valuable to the implementation of load allocations for total dissolved gas.

Monitoring efforts in both the mainstem and the tributaries are currently underway and many will be ongoing under the direction of various agencies and stakeholder groups throughout the implementation process. The information developed through these efforts may be used to revise portions of the TMDL, and determine and adjust appropriate implementation measures and control efforts. If changes to the TMDL are deemed appropriate, they are not expected to result in the production of a new TMDL document. Minor changes will potentially be handled through a letter amending the existing document(s). More extensive changes may require supplementary documentation or replacement of existing chapters or appendices. The goal will be to build upon rather than replace the original work wherever practical. The schedule and targets for reviewing new data will be addressed in the implementation plans. The opportunity to potentially revise the TMDL and necessary control measures is consistent with current and recently developed TMDL guidance, which emphasizes an iterative approach to TMDL development and implementation. However, any additional effort on the part of the DEQs to revise the TMDL or implementation plan and control efforts will most likely be addressed on a case-by-case basis.

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2.5 Pollutant Sources

The SR-HC TMDL reach and its tributaries exhibit altered streamflow dynamics. Flows in the SR-HC TMDL reach (RM 409 to 188) are highly regulated for agricultural irrigation, flood control, and hydropower generation. Additional anthropogenic activities have adversely impacted water quality through increased pollutant loading to the Snake River system. As discussed previously, these activities have resulted in changes to pollutant loading, transport, processing and deposition within the SR-HC TMDL reach. The degradation of water quality in the SR-HC TMDL reach (RM 409 to 188) is caused to some degree by pollutant sources related to agricultural activities, flood control, flow modifications, hydroelectric activities, industrial activities, impoundments, mining, municipal waste, and urbanization.

2.5.1 Watershed Discussion

The SR-HC watershed contains two major types of pollutant sources: point sources and nonpoint sources. Several NPDES permitted point sources discharge directly to the mainstem Snake River; many others discharge to the inflowing tributaries under NPDES permits. The discharges to the mainstem Snake River represent a minor contribution to the total pollutant loading to the SR-HC TMDL reach (RM 409 to 188) due to their extremely small contribution to overall flow. The predominant source of pollutant loading to the SR-HC TMDL reach is from nonpoint source loads to both the mainstem and the inflowing tributaries (IDEQ, 1988a and 1988b; IDEQ, 1997a; USDOE, 1985; IDEQ, 1985).

2.5.2 Point Source Pollution

For the SR-HC TMDL reach (RM 409 to 188), point sources discharging directly to the mainstem Snake River include: food processors, hydroelectric facilities, industries and municipalities (Table 2.5.0). Certain municipal, industrial and construction sources of stormwater runoff are considered point sources and are regulated by NPDES permits, either general or site specific. Most stormwater permits require pollution prevention plans. A more detailed listing of point source dischargers is available in the loading analysis sections (Section 3.0).

2.5.3 Nonpoint Source Pollution

Nonpoint sources within the SR-HC TMDL reach (RM 409 to 188) include: agricultural land-use including irrigated and non-irrigated croplands, and irrigated and dryland pasture (grazing); urban/suburban land use including urban storm sewers, runoff from impervious surfaces and construction activities; recreational uses, including both land and water-based activities; silvicultural practices and legacy mining activities. Associated pollutants include: sediment, nutrients, pathogens, salts, toxic substances, petroleum products and pesticides, which contribute to surface and ground-water quality degradation (US EPA, 2000d, 2000e). Each nonpoint source category is discussed in greater detail in the following sections.

Table 2.5.0. Permitted point sources discharging directly to the Snake River within the Snake River - Hells Canyon TMDL reach (RM 409 to 188).

Point Source	NPDES Permit Number	Location (RM)	Treatment Type	Current Design-flow (MGD)
City of Nyssa	101943 OR0022411	385	Activated sludge	0.8
Amalgamated Sugar	101174 OR2002526	385	Seepage ponds	Seepage
City of Fruitland	ID0020907	373	Facultative lagoon	0.5
Heinz Frozen Foods	63810 OR0002402	370	Activated sludge	3.4
City of Ontario	63631 OR0020621	369	Facultative lagoon	3.1
City of Weiser (WWTP)	ID0020290	352	Activated sludge	2.4
City of Weiser (WTP)	ID0001155	352	Settling pond	0.5 MGD (max) 0.09 MGD (avg)
Brownlee Dam (IPCo) [1]	ID0020907	285		15
Oxbow Dam (IPCo)[1]	101275 OR0027286	272.5		11
Hells Canyon Dam (IPCo)[1]	101287 OR0027278	247		9

1. Facilities sump discharge and turbine cooling water, not a waste treatment source.

In the discussion of nonpoint pollutant sources and in the segment-specific sections earlier, specific land use practices are identified as resulting in negative water quality impacts and increased pollutant loading. It should be kept in mind that these land use practices, when managed in a responsible and conscientious fashion do not result in decreased water quality. However, these land uses can lead to decreased water quality where poor management, or inadequate controls are practiced.

For example, grazing is identified below as a potential source of bacteria, nutrient and sediment loading to the watershed. This should not be interpreted as implying that all grazing results in degraded water quality. Rather, poorly managed or improper grazing practices may result in increased pollutant loading, while proper management and location considerations in a grazing plan can be expected to result in minimal if any impact to water quality. Therefore, the discussion below should not be interpreted as an identification of land use practices in general as being detrimental to water quality. It should be noted that poor land use practices can be improved and direct, long term benefits to water quality can be realized.

2.5.3.1 AGRICULTURAL MANAGEMENT SOURCES

Agricultural land use totals 140,000 acres within the SR-HC TMDL reach (RM 409 to 188). The largest portion of this acreage, dryland pasture and dryland hay, accounts for 51 percent of the agricultural acreage, irrigated row crops make up 17 percent of the acreage and small grain crops account for 32 percent of the total agricultural acreage in the SR-HC TMDL reach (Figure 2.5.1).

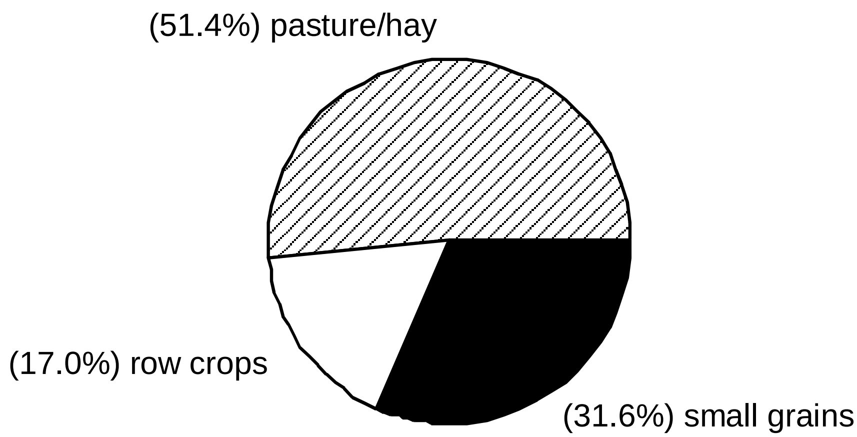

Figure 2.5.1 Agricultural land use distribution in the Snake River - Hells Canyon TMDL reach (RM 409 to 188).

The primary pollutants associated with agriculture are sediment and nutrients present in both dissolved and sediment-bound forms as shown in Table 2.5.1. Related impacts are alteration of stream flows and temperatures. Pesticides are also associated with agricultural land uses; however, the pesticides of concern within the SR-HC TMDL are legacy pesticides no longer used in agricultural practices. The incidence and transport of these compounds are therefore not associated with application and use schedules, rather, they are associated with the movement of sediment and organic matter within the SR-HC TMDL reach (RM 409 to 188). The generation and transport of pollutants from agricultural nonpoint sources are influenced by the health of riparian areas through which water is transported to the mainstem Snake River and its tributaries, overland flow from runoff and snow-melt, irrigation practices, pasture and grazing management and fertilizer application (NRCS, 1995a, 1995b).

Cropping

Effects from inappropriate cropping practices include direct and indirect effects related to sediment, nutrient and pesticide loading. Primary transport mechanisms for sediment and other associated pollutants are wind and water erosion. Previously, agricultural practices that left soil bare for extended periods of time often resulted in substantial erosion rates. Improved conservation tillage practices are reducing the impacts of erosion on surface waters.

In both irrigated and non-irrigated cropland, runoff containing sediment and other associated pollutants (most commonly nitrogen, phosphorus and pesticides) generally occurs during winter

Table 2.5.1 Potential pollutant loading from agricultural management sources

Management Practices	Resulting Status of Sediment Loads	Resulting Status of Nutrient Loads	Resulting Status of Other Pollutants
Non-irrigated Cropland	Increased sediment load during winter snowmelt and spring rain when soil is least protected by plant growth	Nutrient transport during storm events, correlated with sediment transport and fertilizer application Nitrogen transport in early winter	Increased bacterial levels from manured fields Potential transport of Ag. pesticides
Irrigated Cropland (sprinkler, row and flood irrigation techniques)	Irrigation induced erosion and sediment transport Increased sediment load during winter snowmelt and spring rain when soil is least protected by growth	Nutrient transport during storm events, correlated with sediment transport and fertilizer application Nitrogen transport in early winter	Increased bacterial levels from manured fields Potential transport of Ag. pesticides
Riparian Grazing and Watering	Increased sediment load Increased erosion Vegetation reduction/removal Higher stream temps	Increased nutrients from animal waste deposition and transport within the channel Greater dissolution of nutrients at elevated temps	Increased bacterial levels
Over Utilization of Pasture	Increased erosion-sheet and rill Increased transport of sediment Decreased stubble height Soil compaction leading to reduced water infiltration	Increased nutrient load from animal waste deposition Increased nutrient transport from overland flow caused by soil compaction and decreased stubble height	Increased bacterial levels
Flood Irrigation	Removal of soil fines from surface and subsurface Increased bank erosion from subsurface drainage and recharge Subsurface saturation, decreased permeability and increased erosion from surface runoff	Prolonged saturation leads to anaerobic soil conditions and decreased capacity for phosphorus sorption Removal of soil fines decrease surface area of soils and decreases available capacity for phosphorus sorption	

and spring snowmelt, and during rainfall conditions where the soil is least protected by plant growth. Irrigation induced erosion is the major contributor of sediment and associated pollutants to surface waters from irrigated croplands. The most serious irrigation induced erosion is from surface applied systems, primarily furrow irrigation. Erosion from sprinkler irrigation can also be substantial if the rate of water application exceeds the soil infiltration capacity (IDEQ, 1993a; USDA, 1996).

Tilled cropland is additionally susceptible to erosion during the spring when crops are newly planted and furrows are not well established. The majority of sediment transported by water movement in cropped land is fine particulate containing many adsorption sites for nutrients and other pollutants. Heavy or large particle sizes are not commonly transported off-site by moving water or wind. The preferential removal of fine particle size sediment from a cropped field can result in increased pollutant transport in surface water due to greater availability of adsorption sites in the small particles, and decreased adsorption capacity in the field due to removal of soil fines.

The small particle-size soil fractions preferentially removed from the subsurface through irrigation practices are deposited within the flow channel after irrigation flows discharge to streams and tributaries. Material deposited in this fashion can function as a pollutant source to the overlying water column. Natural processes act to maintain equilibrium between pollutant concentrations in the bed-sediments and the flowing water. Thus, if pollutant concentrations in the overlying water are less than concentrations occurring within the deposited sediments, sorbed pollutants will be more readily desorbed from the sediments and dissolved into the flowing water. This process acts to enrich tributary inflow concentrations to the mainstem Snake River system, and to extend the peak input period to the mainstem Snake River system beyond the traditional irrigation season (Sonzongi, 1982).

Additionally, improper timing or excessive application of fertilizers to cropped fields can result in nutrient transport to surface and ground waters. Similarly, agricultural pesticides may be transported to surface waters or leached to ground water if improperly applied. Best management practices and recommended application protocols for fertilizers and pesticides can reduce the potential for negative impacts to the environment (IDEQ, 1993a; Olness *et al.*, 1975; Sharpley *et al.*, 1992; Sharpley *et al.*, 1991; Tisdale *et al.*, 1993; USDA, 1996)

Grazing
Effects from inappropriate grazing practices include direct and indirect effects related to sediment and nutrient loading. Local streams represent the major source of water for livestock and a secondary source of forage. Access to streams is generally unrestricted. Cattle grazing along the stream banks and within the channel exacerbate erosion in two main ways. The shearing action of hooves on stream banks destabilizes the soil and increases the potential for significant erosion as loose sediments are rapidly removed by flowing water. Grazing cattle also remove or substantially reduce riparian vegetation (Platts and Nelson, 1985a, 1985b; Platts 1983; Armour *et al.*, 1991). Bank erosion is accelerated where riparian vegetation has been removed or heavily grazed. Streambank vegetation acts to stabilize bank sediments and reduce the erosive force of flowing water. It also serves as a depositional area for sediment already in the stream. Water entering vegetated reaches slows down because of the resistance plant stems create within the flow path. As flow velocity decreases, sediment particles settle out within the riparian areas. Reduction or removal of riparian vegetation decreases bank stability through the loss of root mass within the soil profile and decreases settling and sedimentation at the edges of the stream channel. As a result, stream banks have become unstable in many stream reaches.

In addition to increased erosion and sediment transport effects, inappropriate grazing practices can also contribute to nutrient loading through the deposition and transport of animal wastes. A small portion of the available phosphorus in plant material is used in growing and maintaining bones and teeth, grazing animals partition nearly all phosphorus intake into manure. Manure has a slower physical decomposition rate than plant material on the surface. This results in increased accumulation of soluble phosphorus in a physically unstable form within the pasture (Khaleel *et al.*, 1980; USDA, 1996). Such deposition is especially noticeable when correlated with the spatial distribution of animals in grazing and bedding routines. Cattle within a grazed pasture rarely spread out and cover the entire acreage evenly. Rather, they tend to congregate around areas where water is readily available and forage is plentiful. Because greater numbers of livestock are concentrated in such areas, a greater proportion of the manure produced is deposited in or near stream channels and riparian areas. Manure concentration per unit of land is relatively small because the total grazed-land area is commonly large, however, manure concentration correlates well with major water bodies, resulting in a greater potential for direct transport.

The phosphorus contained within manure is in a highly soluble, readily bioavailable form. Because of the high solubility, phosphorus loading and transport from a manured field can exceed those from a non-manured field by many times (Khaleel *et al.* 1980; Olness *et al.* 1975; Omernik *et al.* 1981; Reddell *et al.*, 1971; Hedley *et al.*, 1995; Sharpley *et al.* 1992). Erosive processes occurring within an ungrazed or forested watershed would require a significantly greater amount of time and transport to produce the same effect on bioavailable phosphorus loading as a direct deposition of phosphorus-rich animal wastes into the channel or flood plain of a stream.

Related impacts include increased water temperatures in the tributaries due to removal of streamside vegetation, allowing greater dissolution of adsorbed phosphorus and other nutrients from sediment-bound forms. Also, monitoring performed above and below grazed land in other watersheds has shown higher levels of bacterial loading in waters below the grazed area than in those above (Lappin and Clark, 1986; USDA, 1996; Zimmer, 1983). This is most probably due to deposition of manure in and around streams and overland transport of manure through storm events and spring runoff. Additionally, improper grazing practices can alter floodplain and hydrologic characteristics, resulting in an increase in width-to-depth ratios of streams, exposing more of the flow volume to the air.

Erosion from storm events, combined with reduced vegetation from improper grazing management also results in increased sediment transport to stream channels. In a related fashion, over utilization of pasture land can result in subsurface compaction of soils as hoof action combined with animal weight create a pressure wave that compresses the soil profile, resulting in the formation of a dense layer of low permeability twelve to fifteen inches below the soil horizon (Weltz *et al.*, 1989; Orodho *et al.*, 1990; Mapfumo *et al.*, 1999; Gilley *et al.*, 1996). In storm events and spring melt, water cannot penetrate this compacted layer, and the volume and velocity of overland flows are increased, as is the total suspended sediment and nutrient load. Vegetation in over-utilized pasture areas is commonly insufficient to retain sediment carried by overland flow and deposited manure is easily transported directly into the channel and downstream within natural stream and/or irrigation channels (NRCE, 1996).

It should be noted that the grazing impacts identified above commonly associated with poor management of domesticated livestock can also occur as a result of the management of wild game such as deer, elk and wild horses if populations are manipulated to levels greater than those that would occur without human intervention. For example, elk herds can trample vegetation in a manner similar to cattle and have been known to destroy newly established riparian vegetation in the upstream sections of tributaries to the Snake River (IDFG, 2000).

Irrigation

Flood and sub-flood irrigation, commonly used to irrigate pastureland, also impact sediment and nutrient loading if practiced in an inappropriate manner. In flood and sub-flood irrigation, water diverted from natural streams is applied in excess to pasture land through a series of canals and ditches. These canals are filled and water is allowed to saturate the surrounding soil, creating an artificially high water table. Practices like flood and sub-flood irrigation that substantially alter the water table can lead to changes in the mobility of phosphorus within the shallow subsurface.

Phosphorus has been observed to move more easily through soils that are consistently waterlogged because the majority of the iron present in these soils is no longer in the chemical form (Fe^{+3}) required for greatest sorption potential. As a result, adsorption occurs less efficiently or at greatly reduced rates within the soil profile (Sharpley *et al.*, 1995). In addition, movement of water in subsurface layers results in the preferential loss and transport of small particle-size soil fractions, which represent the primary source of phosphorus sorption sites in the soil. These particles carry a significant amount of sorbed phosphorus with them when they are removed and leave the remaining soil deficient in sorption sites. Therefore, not only is the subsurface water enriched directly through the sorbed phosphorus on the particulates, but further runoff from the original soils will be enriched due to the decrease in phosphorus sorption capacity (Hedley *et al.*, 1995). In addition, phosphorus sorption-desorption characteristics, buffer capacity and the sorption index of the transported sediments are altered, and the equilibrium phosphorus content of the runoff waters is usually enriched (Shapely *et al.*, 1995).

The small particle-size soil fractions preferentially removed from the subsurface through flood and sub-flood irrigation practices are deposited within the flow channel after irrigation flows discharge to streams and tributaries. Material deposited in this fashion can function as a nutrient source to the overlying water column. Natural processes act to maintain equilibrium between nutrient concentrations in the bed-sediments and the flowing water. Thus, if nutrient concentrations in overlying water are less than nutrient concentrations occurring within the deposited sediments, sorbed nutrients will be more readily desorbed from the sediments and dissolved into the flowing water. This process acts to enrich tributary inflow concentrations to the mainstem Snake River system, and to extend the peak nutrient input period to the mainstem Snake River system beyond the traditional irrigation season (Sonzongi, 1982).

Irrigation recharge and surface runoff created by flood and sub-flood irrigation practices are diverted to local streams or returns as shallow subsurface recharge. These waters generally contain high concentrations of phosphorus and nitrogen as compared to ambient concentrations of local streams (IDEQ, 1988b; Omernik *et al.* 1981; Shewmaker, 1997). These same irrigation systems funnel and accelerate delivery of runoff from snowmelt during spring thaw. In addition, inefficient irrigation water management practices can reduce stream flows unnecessarily, resulting in increased water temperatures.

In many areas of the Snake River watershed flood and sub-flood irrigation return flows are discharged into streams and rivers. While it has the potential to be enriched in nutrients, this subsurface recharge can act to increase instream flows, resulting in lower temperatures and improved fish habitat in some areas (IDFG, 2000, IDEQ, 1998b). In addition, these practices have created subsurface flow and resulted in the formation of wetland areas in many pasturelands (IDEQ, 1998b). Similarly, when irrigation practices occur in proximity to natural or man-made surface water systems, subsurface recharge can result in the extension of riparian zones and improved bank stabilization by increased riparian vegetation. Well managed irrigation flows can act to extend the health of such riparian or "created" wetlands into the late summer months. Without these surface and subsurface flows, this vegetation would normally only be present in the spring and early summer months.

2.5.3.2 RECREATIONAL SOURCES

A variety of recreational opportunities are available in the SR-HC TMDL reach (RM 409 to 188) and the surrounding watersheds. Potential impacts from recreational uses are varied, ranging from increased erosion potential caused by irresponsible off-road vehicle use, to direct contamination of surface water by personal watercraft or accidental fuel spills. Pollutants of concern generated by recreational use in the watershed include (but are not limited to) bacterial and nutrient contamination from human and animal waste from improper sanitary disposal, organic material from fish cleaning, hydrocarbons from outboard motors, and nutrients, grease and oils from parking lot runoff at camp grounds and boat ramps (Table 2.5.2). Sediments are also contributed by erosion of banks around popular beach areas and camping sites, and heavy use of native-surface roads, particularly during the wet season. Because recreational activities occur predominantly on the water or at the shoreline, delivery potential for recreational pollutant sources is very high. Therefore, the majority of the pollutants generated by recreational activities have the potential to directly influence water quality.

Table 2.5.2 Potential pollutant loading from recreational activities.

Management Practices	Resulting Status of Sediment Loads	Resulting Status of Nutrient Loads	Resulting Status of Other Pollutants
Recreational Users	Increased sediment from off-road and irresponsible camping vehicle use	Increased nutrient load from improperly disposed wastes	Increased bacterial levels from improperly disposed human, fishing, and hunting wastes Increased petroleum products in water column from motorized boats and/or personal watercraft use and maintenance and/or fueling practices

2.5.3.3 URBAN/SUBURBAN SOURCES

Urban/suburban land use totals 6,700 acres within the SR-HC TMDL reach (RM 409 to 188). The largest portion of urban/suburban acreage in the reach (72%) is contained in private and public roads and highways, and their respective right-of-ways. Low intensity residential acreage (rural subdivisions and city impact areas) accounts for 24 percent of the urban/suburban acreage in the reach and suburban/recreational residential acreage makes up the remaining 4 percent, as shown in Figure 2.5.2. High intensity (urban) development exhibiting from 80 to 100 percent impervious coverage does not occur within the SR-HC TMDL reach (RM 409 to 188), but is present in some of the tributary watersheds. The City of Boise and its associated urban area are located in the Lower Boise River watershed (HUC 17050114), and the City of Ontario and its associated urban area are located in the Owyhee River watershed (HUC 17050110). (Note: USBR GIS coverage locates the City of Ontario in the Owyhee River watershed as stated above. A separate GIS coverage used by US EPA shows the City of Ontario as located in the Hells Canyon watershed (HUC 17060101).)

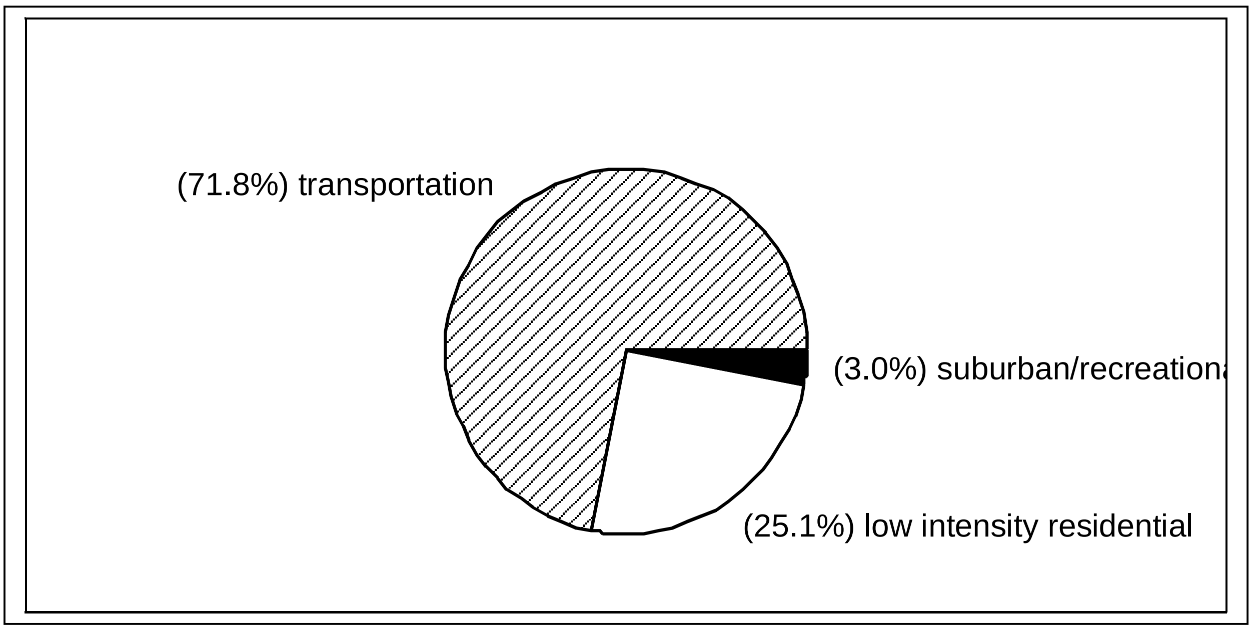

Figure 2.5.2 Urban/suburban land use distribution in the Snake River - Hells Canyon TMDL reach (RM 409 to 188).

As outlined above, there are three primary components to urban/suburban land use in the SR-HC TMDL reach (RM 409 to 188): low intensity residential land use, suburban/recreational residential land use, and transportation corridors (roads and highways). Pollutant sources of concern associated with urban/suburban land use include (but are not limited to) stormwater and other impervious surface runoff, improperly functioning septic systems and construction-based loading concerns. Potential effects from urban/suburban management practices are listed in Table 2.5.3.

Stormwater Runoff

Stormwater runoff, occurring when precipitation and runoff events result in excess water movement through urban/suburban systems, road and other major construction projects can result in substantial degradation to water quality if not properly treated. These event-driven flows often act to remove pollutants from impervious surfaces and transport pollutant loads through storm sewers, road swales and drainage ditches to discharge directly to surface and ground-water systems. While most major municipalities within the SR-HC system have stormwater management plans in place or in progress, many other stormwater collection and delivery systems discharge to surface and ground water with little or no pre-treatment.

In most rural residential areas the quantity and quality of stormwater runoff is unknown. However, several well-validated and extensively used models have been developed for quantifying urban runoff and stormwater pollutant loads (Chandler, 1994, 1993; FHWA, 1987; Schueler, 1987; USGS, 1995; US EPA, 1992c). Pollutant sources of concern associated with urban stormwater and other impervious surface runoff includes nutrients from lawn fertilizers and improperly disposed of animal wastes, sediment from erosion of conveyance systems, private properties and ditches, oils, pesticides and bacteria. Certain municipal, industrial and construction sources of stormwater runoff are considered point sources and are regulated by NPDES permits, either general or site specific. Most stormwater permits require pollution prevention plans.

Table 2.5.3 Potential pollutant loading from urban/suburban management practices.

Management Practices	Resulting Status of Sediment Loads	Resulting Status of Nutrient Loads	Resulting Status of Other Pollutants
Stormwater Runoff	Increased sediment from snow management and construction practices	Increased sediment-bound nutrients from runoff and construction	Petroleum products and home/ lawn care chemicals
Failing Septic Systems	Nominal: construction induced increases only	Increased nutrient load in highly bioavailable form	Increased bacterial levels
Ranchettes and other suburban development	Increased sediment transport from high road and livestock density	Increased nutrient loads from increased animal waste deposition and transport	Increased bacterial levels Increased storm- water pollutants
Sewage Effluent	Nominal: construction induced increases only	Increased nutrient load in highly available form	Increased bacterial levels
Road and Highway Management	Increased sediment from snow management and construction practices	Increased sediment-bound nutrients from runoff and construction	Petroleum products, vehicle wastes and snow/ice management chemicals

Septic Systems

Many rural residential and recreational housing developments within the SR-HC TMDL reach rely on septic systems for the treatment of household and human wastes. Septic systems, if improperly constructed, located or maintained, can act as a source of nutrients and pathogens to surface and ground-water systems due to inadequate retention time and treatment of septic tank effluent. Improper construction of septic systems may be due to age (construction prior to current regulations), or inappropriate capacity or materials (tanks sized too small for usage, tank materials not appropriate for location characteristics or not sealed properly). Improper placement may be due to high ground-water tables, evidence of existing ground-water contamination, and high septic tank density (IDEQ, 1997a; Postma *et al.*, 1992; Alhajjer *et al.*, 1989).

Nutrient and pathogen contributions from septic tank effluent can also be the result of soil characteristics that are inappropriate for septic systems (Reckhow and Simpson, 1980; IDEQ, 1997a) or how well the soil matrix functions in binding and reducing the transport of phosphorus through shallow ground water. The most important soil mechanisms responsible for immobilizing phosphorus are the formation of insoluble iron and aluminum phosphate compounds and the adsorption of phosphate ions onto clay particles (Tilstra, 1972). Seasonal high ground-water tables may also increase the mobilization of phosphorus, ultimately transporting all phosphorus from septic tank effluent to surface and ground-water systems.

Recreational or seasonal housing which depends on septic systems may also represent a nutrient and pathogen source to surface and ground-water systems even if the septic tank and drainfield is properly constructed and located because inconsistent or intermittent usage does not result in the adequate formation of treatment mats within the drainfield (Postma *et al.*, 1992). These mats are formed of organic material and stationary bacterial growth that act to treat outflowing water. In intermittently used systems these mats do not form to the same degree as in continually used systems. Treatment of septic effluent therefore is less effective overall in intermittently used septic systems.

2.5.3.4 LEGACY MINING ACTIVITIES

Legacy mining activities represent a potential source of mercury loading to the SR-HC TMDL reach (RM 409 to 188). In most cases, legacy mining operations were located on tributaries to the mainstem Snake River, however, there are a few located on the mainstem as well. The mercury in these mining sites was used primarily to amalgamate gold and silver. In this process mercury is added in excess to the mined material with the excess being drained away from the site. In some cases, legacy mining activities represent a source of both dissolved and sediment-bound mercury. In addition to the mercury load already present within the mainstem Snake River, existing slag, refuse and leach piles at old mining sites may represent continuing enrichment sources to the SR-HC system. This problem has been observed in other historical mining areas in the western states (CRWQCB, 2000)

2.5.3.5 GROUND WATER

Ground water within the SR-HC watershed can be divided into two major categories: natural ground water and subsurface recharge. Within this document, natural ground water refers to ground water that is present due to geological and non-anthropogenic hydrological processes. It occurs at a variety of subsurface levels, but is predominantly located from 40 to 500 feet below the ground surface. Subsurface recharge refers to sub-surface water present due to anthropogenic practices such as flood and sub-flood irrigation. The water applied in such practices is often perched between the soil surface and one of several existing clay layers known as "hard-pan" or "clay-pan." These layers occur within the watershed at depths ranging from 2 to 10 or more feet below the surface. Because of their relative impermeability, they prohibit infiltration of the water to lower levels and promote an artificially raised water table. This water moves under hydraulic pressure toward low lying areas, discharging into existing stream channels through outlets in the stream banks and eventually into the mainstem river system and tributaries.

Natural ground water within the SR-HC TMDL reach (RM 409 to 188) is commonly of high quality, although general ground-water quality trends in the Snake River watershed indicate an increasing occurrence of nitrate and, to a lesser extent, pesticide contamination in areas with heavy agricultural, urban or industrial impacts. Nutrient concentrations in natural ground water in Idaho commonly average less than 0.02 mg/L total phosphorus and less than 0.75 mg/L nitrate (USGS, 1999; Seitz and Norvitch, 1979; Yee and Souza, 1984). Data on natural ground-water concentrations in Oregon is less available, but shows a similar concentration range (ODEQ, 2000b; USGS, 1999). Sediment loading from natural ground water is minimal for all but the smallest particle sizes due to the sieving effect of transport through the soil matrix.

Nutrient concentrations in subsurface recharge within the Snake River watershed are observed to be higher than those in natural ground water, averaging 0.5 mg/L total phosphorus and 2.25 mg/L nitrate in Idaho (USGS, 1999), with similar concentrations observed in Oregon waters (ODEQ, 2000b; USGS, 1999). As with natural ground water, sediment loading from subsurface recharge is minimal for all but the smallest particle sizes due to the sieving effect of transport through the soil matrix.

2.5.3.6 BACKGROUND AND NATURAL CONTRIBUTIONS

Natural Loading

For the purposes of this document, natural loading is defined as the loading within a water system that originates solely from natural, non-anthropogenic sources. In general, TMDL processes move toward the attainment of natural loading levels rather than requiring the reduction of natural loads. Natural loading to the SR-HC TMDL reach (RM 409 to 188) occurs from a variety of different sources. Sources differ substantially from pollutant to pollutant, and to a lesser degree from segment to segment.

Natural sources of bacteria (and other pathogens) and nutrients include indigenous wildlife and wildfowl that utilize the watershed. While these populations are relatively stable throughout much of the year, substantial increases in some populations are observed with spring and fall migration patterns. Fluctuations in the levels of bacteria from waterfowl are especially noticeable as migration effects are directly correlated with surface water and wetland areas within the watershed.

Increased nutrient loading is often associated with increases in algal mass and chlorophyll *a*, decreases in dissolved oxygen levels, and changes in pH that commonly occur following a major bloom. Natural sources of nutrient loading that may trigger such occurrences include elevated levels of nutrients from natural ground-water inflows or springs, coincident with high solar radiation and low flow velocities associated with low water levels during the dry summer season;

and geological sources of nitrogen and phosphorus such as the Phosphoria deposit located on the mainstem Snake River upstream of the SR-HC TMDL reach. Additional sources of natural nutrient loading include runoff and sediment/erosion associated with natural soils and geologic features, landslides and high velocity flows.

Natural sources of sediment within the SR-HC system include streambank erosion, commonly most significant during high flow and spring runoff conditions (December to June); naturally induced landslides and debris flows that deposit material in the stream channel; and erosion induced by other natural occurrences such as forest fires where native vegetation is removed leaving exposed soils more susceptible to extreme precipitation and runoff events (Beaty, 1994; Saa *et al.*, 1994). All of the sources listed are highly variable in nature and difficult to predict accurately.

Natural sources of increased temperature are predominantly the result of the hot, dry climate of the SR-HC TMDL reach (RM 409 to 188). The area enjoys an average of 124 clear, sunny days, most of which (71%) occur during the summer months. Monthly records for sunshine for the Upstream Snake River segment (RM 409 to 335) show an average of 67 percent of possible sunshine per year with an average of 3.6 cloudless hours/day in December and an average of 13.4 cloudless hours/day in July (US EPA, 1975; SNOTEL, 2000; WRCC, 2000). In addition, native vegetation in much of the watershed is relatively low growing and sparse, providing little shading to some tributary waters. Summer daily maximum air temperatures in the SR-HC TMDL reach averaged 32 ^{o}C (90 ^{o}F) from 1980 to 1999.

No natural sources of the pesticides of concern (DDT and metabolites, and dieldrin) exist within the SR-HC TMDL reach (RM 409 to 188).

Mercury occurs naturally in several geological landforms within the SR-HC TMDL reach (RM 409 to 188). The Owyhee, Malheur and Weiser drainages contain geological landforms known to yield mercury ores. Unsubstantiated anecdotal information from early explorers and settlers in these areas indicate that mercury was present historically at high concentrations in geological outcroppings in close proximity to water systems (IDFG, 2000). Transport and deposition of mercury within the tributaries and the mainstem Snake River system would most likely have been highly correlated with sediment transport in most cases.

Background Loading

For the purposes of this document, background loading is the load delivered to a segment by inflowing upstream waters. Background loads can contain pollutants originating from both natural and anthropogenic sources. In general, TMDL processes move toward reductions in the anthropogenically induced fraction of background loading. In this manner, background load reductions can be assessed and achieved in most systems.

This TMDL process is somewhat unique in the manner of load allocation assessment proposed. Tributary inflows to the SR-HC TMDL reach (RM 409 to 188) will be assessed load allocations at their respective inflows, and tributary-based TMDL processes will work to distribute load allocations upstream, rather than the SR-HC TMDL. Due to this load allocation mechanism, and the inherent connectivity it represents within the Snake River system, background contributions will not be assessed separately from overall loading contributions for inflowing tributary systems within the SR-HC TMDL process. Pollutant loads will be assessed for all major inflowing tributaries directly, including the inflowing Snake River mainstem. The distinction of background loading vs. total loading for each tributary system will be the responsibility of the tributary-based TMDL processes.

2.6 Summary of Past and Present Pollutant Control Efforts

2.6.1 Point Source Efforts

The permitted point sources specific to the SR-HC TMDL reach (RM 409 to 188) are listed in Table 2.5.0.

As stated earlier, the majority of point sources in the SR-HC TMDL reach are located in the Upstream Snake River segment (RM 409 to 335). Point source pollution control efforts within this segment have been centered almost exclusively on improvements to wastewater treatment mechanisms. Substantial improvements have been observed in nutrient, temperature and total suspended solids loading, and in loading of materials resulting in increased oxygen demand, from municipal and industrial wastewater treatment plants since the 1980s. These efforts have the potential to improve water quality in many of the tributary drainages and in turn to improve water quality within the mainstem Snake River.

2.6.2 Nonpoint Source Efforts

The main focus of past and present nonpoint source pollution control efforts has been the Upstream Snake River segment (RM 409 to 335) of the SR-HC TMDL reach. These efforts have the potential to improve water quality in many of the tributary drainages and in turn to improve water quality within the mainstem Snake River.

There has been a long history of research, regional planning, and implemented progress within the SR-HC TMDL reach (RM 409 to 188). In crop production regions, massive conversion from surface irrigation to sprinkler irrigation has helped reduce surface erosion and reduce nitrate leaching by deep percolation through the soil to groundwater (Shock *et al.*, 2001).

This voluntary, proactive tradition in agriculture is present in both Oregon and Idaho. Malheur County residents have written formal regional plans to reduce the losses of sediment and nutrients induced by irrigation in 1980 by a local committee, in 1988 to 1996 through the HUA process, and again in 2000 through the LAC. Malheur Soil and Water Conservation District was formed in Vale in 1953. The Adrian Soil and Water Conservation District was organized in 1958. The two districts consolidated into the Malheur County Soil and Water Conservation District in 1974. Every year, plans have been made for individual properties. Annual reports are available for the above mentioned years to the current 2000. The Ontario Hydrologic Unit Area reports are from 1990 to 1997. Individual annual reports and a final report for 1990 to 1997 are in the SWCD Ontario Office (Shock *et al.*, 2001). A listing of water quality plans is shown in Table 2.6.1.

Improvements in practices were supported by numerous federal, state and local programs including the Conservation Reserve Program (CRP), the Habitat Improvement Program (HIP), Wildlife Habitat Incentive Program (WHIP), Wetland Reserve Program (WRP), and the Environmental Quality Incentives Program (EQIP).

Table 2.6.1 Management plans for water quality improvements in the Snake River - Hells Canyon TMDL drainage area.

Plan	Location	Author
Progress Report First Year Sampling Program (Malheur and Owyhee)	Malheur and Owyhee drainage, Oregon	Malheur County Planning Office. 1979, NPSWQMPP, Vale, OR.
Technical Inventory Report for May to September 1978 (Malheur and Owyhee).	Malheur and Owyhee drainage, Oregon	Malheur County. 1978.
Two-year Sampling Program, Malheur County Water Quality Management Plan, 1981.	Malheur County, Oregon	Malheur County. 1981.
Draft Watershed Management Plan.	Malheur County, Oregon	Malheur County. 2000.
Malheur River Basin Agricultural Water Quality Management Area Plan (Draft).	Malheur County, Oregon	Malheur River Basin Local Advisory Committee. 2000.
Malheur Basin Action Plan.	Malheur County, Oregon	Technical Malheur-Owyhee Watershed Council. 1999.
Harney County Comprehensive Plan, Water Element	Harney County, Oregon	Harney County, Oregon
Lower Payette River and Implementation Plan	Gem County, Idaho	IDEQ, 1999
Lower Boise River and Implementation Plan	Ada County, Idaho	IDEQ, 1998

2.6.3 Upstream TMDL Efforts

Many of the projects mentioned above are the result of upstream and tributary TMDL processes. TMDLs and agricultural management plans are currently in place in the Mid-Snake (RM 638.7 to RM 544.7), Owyhee, Boise, Payette, and Malheur river watersheds. The implementation measures associated with these plans represent mechanisms specifically targeted to reduce bacteria, nutrient, sediment and temperature impacts to the upstream and tributary watersheds. In many cases, tributary-based implementation has already begun and is showing positive trends in water quality. These improvements may lead to water quality benefits in the SR-HC TMDL reach (RM 409 to 188).

2.6.4 Potential for Achievement of Water Quality Standards with Present and Planned Activities

If the TMDLs currently in place are fully implemented, and the pollutant reduction measures identified perform at the expected efficiencies, achievement of water quality standards and full support of designated beneficial uses are expected to result in the respective tributary drainages for which TMDLs have been approved. If the pollutant reduction measures identified perform at efficiencies below those expected, the iterative assessment processes present in the TMDL will be called upon to identify additional measures for reduction. In this manner, achievement of water quality standards and full support of designated beneficial uses in the tributaries will be realized, but through an extended time frame. The implementation of planned pollutant loading reduction activities is expected to benefit from the evaluation of reduction efficiencies in those measures already in place. Those measures observed to function efficiently, with consideration for both water quality benefits and cost per reduction realized, would be expected to be considered for more wide-spread implementation within the watershed.

The potential exists for water quality improvements within the SR-HC TMDL reach (RM 409 to 188) due to implementation of upstream and tributary TMDLs. However, tributary TMDLs currently in place do not address all of the pollutants of concern in the SR-HC TMDL reach, and do not address the direct needs and status of designated beneficial uses in the SR-HC TMDL reach.

2.6.5 Adequacy of Efforts to Date

To date, the pollutant control measures currently in place have not resulted in attainment of state-specific water quality criteria for dissolved oxygen, mercury, nutrients, sediment, pesticides and temperature for those segments of the SR-HC TMDL reach (RM 409 to 188) specifically listed for these pollutants. As a result, the designated beneficial uses of fishing, salmonid spawning and rearing, cold water aquatic life, and resident fish and aquatic life, within the SR-HC TMDL reach have not been brought back into full support status through these upstream and tributary-based efforts.

Additional efforts specific to the SR-HC TMDL process are expected to be necessary to allow the SR-HC TMDL reach (RM 409 to 188) to meet water quality criteria and fully support designated beneficial uses. However, it should be clearly noted that many of the improvement efforts associated with upstream and tributary TMDLs require an extended time period to achieve the water quality targets identified. It should also be recognized that due to the relatively short time since approval of these TMDLs, sufficient time has not elapsed for full implementation and effective operation to be realized. Water quality trends are expected to improve within the upstream and tributary drainages as full implementation is achieved and specific projects mature to full operational efficiency.

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